UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27711

DATE: APR 21 1980

SUBJECT: Technical Assistance on BACT Emission Limit for Intermountain Power Project (IPP)

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The purpose of this memo is to document our response to your technical assistance request dated 4/1/80. Since receipt of that request on 4/4/80, members of our staff have reviewed your transmittal package and evaluated all available data that is relevant to the subject. Further, our staff members have had several telephone discussions with members of your staff during the period 4/7 to 4/10/80.

Our position on the NO_x emission limit for IPP is as follows:

- A NO_x emission limit of 0.6 lbs/10^6 Btu is achievable based on available data and characteristics of the coal proposed for use by IPP. Additionally, the 0.6 standard is consistent with the NSPS promulgated on June 11, 1979 in that the coal proposed for use is classed as bituminous.

- A NO_x emission limit of 0.55 lbs/10^6 Btu is probably achievable based on our experience and field test results at Utah Power and Light Company's Huntington Canyon No. 2 which burned a Utah "B" bituminous coal with chemical/physical characteristics within the range presented for the IPP coal. Additional supporting information is contained in Attachment 1.

- A NO_x emission limit of 0.5 lbs/10^6 Btu (on a continuous basis) cannot be supported based on available data. However, since the IPP units

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have not as yet been designed, a 0.5 lbs/10^6 Btu limit could be proposed as a goal. This position is based on our understanding that boiler manufacturers can design boilers with more liberal furnace volume, and consequently lower heat release rates. This should reduce furnace slagging potential and permit operation at the 0.5 lbs/10^6 Btu level. Additional supporting information is contained in Attachment 1.

Please keep us advised on the status of this project. If we can be of further assistance, especially after boiler designs are developed, please do not hesitate to contact us.

Attachment

Attachment 1: <u>Experience at Huntington Canyon No. 2, and Its Relevance to IPP</u>

Huntington Canyon No. 2 is a modern tangentially-fired unit built by Combustion Engineering, Inc. It was designed to meet the 1971 NSPS of 0.7 lbs $NO_x/10^6$ Btu. It is equipped with overfire air ports for NO_x control. These ports provide for introduction of up to 20 percent of the total combustion air requirements above the fuel admission nozzles at full unit loading. Additionally, the unit has provisions for fuel/air and overfire air nozzle tilting ($\pm$ 30 degrees vertically) and separate air compartment flow dampers. Its major design features are:

Generator rating, MW	400
Main steam flow @ MCR (lb/hr)	3,036,000
Reheat steam flow @ MCR (lb/hr)	2,707,000
Superheat outlet temp. (°F)	1,005
Superheat outlet press. (PSIG)	2,645
Reheat outlet temp. (°F)	1,005
Reheat outlet press. (PSIG)	559
Mills (number)	5
Fuel elevations	5

The unit was extensively tested as part of an EPA program (Contract 68-02-1486) to evaluate the performance of tangentially fired units firing western bituminous and subbituminous coals. Testing at Huntington Canyon was performed during the period 4/30/75 to 11/23/75. Results from this study are documented in the final report "Overfire Air Technology for Tangentially Fired Utility Boilers Burning Western U.S. Coal," EPA-600/7-77-117, October 1977.

During the course of this testing, it was found that the degree of NO_x control on this unit firing the Utah "B" bituminous coal was frequently limited by slagging characteristics of the coal. At times, slag deposits became very heavy and running (molten) slag in excess of 4 inches thick were observed. These generally occurred when low NO_x conditions using reduced levels of excess air in the fuel firing zone were attempted. During those periods when clean furnace walls could be maintained, NO_x levels at full load were quite low (about 0.45 lbs/10^6 Btu). However, these were relatively short term tests of about one hour duration.

Following the short term optimized tests, the unit was subjected to a nominal 30-day run under optimized low-NO_x conditions. Unit load followed system demand as scheduled by the dispatcher. Unit load varied from about 200 MW to 425 MW. The average MW loading during the 30-day period was 347 MW. Continuous NO_x monitoring was not performed during this program, but a calculated 30-day average was made based on unit loading and our experience with NO_x levels at various loads and conditions of slagging. On this basis, the NO_x ranged from 0.44 to 0.58 lbs/10^6 Btu, with a 30-day average of 0.54 lbs/10^6 Btu.

There are several important factors that must be appreciated when reviewing this data. First, ash fusion temperature and other coal performance indices and their effect on furnace wall slagging bear very heavily on how a boiler must be operated if load requirements are to be met. Second, the most effective method for controlling slag (in addition to operation of soot blowers) is to increase excess air in the furnace firing zone. This, however, increases NO_x. Third, although low NO_x levels (about 0.45 lbs/10^6 Btu) could be achieved during short-term optimized tests, the real-life situation is somewhat different under routine overfire air operation as evidenced by the 30-day test data. Here, furnace walls at times slagged heavily. When this occurred, the operator would increase excess air to the fuel firing zone to shed slag. This in turn caused NO_x levels to increase. Heavy slag deposits cause furnace heat absorption rates to decrease and furnace temperatures increase with a consequent increase in thermal NO_x. Additionally, it is inadvisable to allow slag deposits to build up too heavily. If this should occur, slag may break off due to its mass and fall into the ash hopper with the risk of an explosion. One need only be present at such an occurrence to become a believer!

Table 1 compares properties of the coal and ash properties for the IPP and Huntington Canyon coals. The analyses lead us to expect that the NO_x emissions levels and slagging potential for the IPP coal should be no different than was experienced with the Huntington Canyon coal. In addition to ultimate coal analysis, ash component analysis and ash fusion temperatures we have included information on other performance indices that are used to estimate a coal's slagging potential. These include the ratios of base/acid, iron/calcium and silica/alumina.

Base/Acid Ratio: This provides a means for understanding ash performance as it occurs under furnace conditions. It is expressed as:

$$\frac{Fe_2O_3 + CaO + MgO + Na_2O + K_2O}{SiO_2 + Al_2O_3 + TiO_2}$$

In general, acidic oxides produce higher melting temperatures and will be lowered somewhat proportionally by the amounts of basic oxides available for reaction. However, these oxides interact chemically at furnace conditions to form complex salts of lower melting temperatures. Generally, ash with a base/acid ratio below 0.25 and greater than 0.80 will exhibit high fusibility temperatures and thus will be less troublesome from the viewpoint of slagging. Ash with base/acid ratios between 0.25 and 0.80 will exhibit lower fusibility temperatures and will be more prone to slag. Both the IPP and Huntington Canyon coals have base/acid ratios that fall within that range. The experience at Huntington Canyon supports this slagging potential.

Iron/Calcium Ratio: Although iron and calcium produce basic reactions, they interact in a complex fashion and produce an eutectic with a lower melting temperature than either alone. This effect is most pronounced when the ratio is in the range of about 0.3 to 3. Typically, ash from Western coals has ratios less than 1.0 and exhibit low fusibility temperatures and thus are more prone to slag. This is again evident for the IPP and Huntington Canyon coals.

Silica/Alumina Ratio: This ratio can give guidance relating to ash fusibility temperature. These oxides are acidic and have high melting temperatures. However, the silica is considered to be more likely to form low melting complexes, e.g., silicates, with basic constituents than is the alumina. With coals having equal, or near equal, base acid ratio, the one having the higher silica/alumina ratio will produce lower fusibility temperatures and be more prone to slag. The ash analysis for IPP suggests this possibility.

Summary

Our analysis of relevant field test data and coal and ash properties leads us to believe that attainment of a NO_x emission limit in the range of 0.55 to 0.60 lbs/10^6 Btu is achievable for IPP. A NO_x emission limit of 0.5 lbs/10^6 Btu is not supported based on available data. Nonetheless, the more stringent limit is not unreasonable as a goal. We feel that attainment of the 0.5 limit on a continuous basis may be limited by slagging characteristics of the coal as experienced on a modern unit. This does not preclude incorporation of other design features, such as enlarged furnace volume, to minimize slagging in a new unit design. Further, experience with low-NO_x burner design for both wall-fired and tangentially fired units should be available in about two years and should provide a defensible basis for more stringent NO_x emission limits.

Table 1. Comparison of Coal and Ash Properties

Ultimate Analysis (Weight percent, as fired)

	IPP coal	Huntington Canyon coal
Carbon	62.35-75.42	66.80
Hydrogen	4.32- 5.30	5.23
Oxygen	9.26-14.93	9.80
Nitrogen	1.02- 1.46	1.28
Sulfur	0.44- 0.78	0.45
Moisture	4.50-10.46	7.99
Ash	4.29- 9.77	8.45
HHV, (Btu/lb)	11,900-13,650	12,113

Ash Analysis (Weight percent)

	IPP coal	Huntington Canyon coal
Fe_2O_3	3.53-10.75	4.7
CaO	4.82-20.65	8.9
MgO	0.96- 4.68	1.1
K_2O	0.22- 1.21	0.6
Na_2O	0.07- 3.88	5.2
SO_3	3.38-14.63	6.6
P_2O_5	0.04- 0.51	-
SiO_2	35.88-65.43	51.5
$A\ell_2O_3$	8.34-18.21	17.0
TiO_2	0.26- 1.04	1.0

Ash Fusion Temperature (Oxidizing, °F)

	IPP coal	Huntington Canyon coal
Initial Deformation	2130-2425	2130
Softening (H=W)	2140-2435	2200
Fluid	2170-2455	2450

Other Performance Indices:

	IPP coal*	Huntington Canyon coal
Base/Acid Ratio	0.37	0.30
Iron/Calcium Ratio (Fe_2O_3/CaO)	0.56	0.53
Silica/Alumina Ratio ($SiO_2/A\ell_2O_3$)	3.82	3.03

* These are calculated ratios based on ash analysis. Since a range of values was given for the IPP coal, midpoint averages were selected for the calculation. Consequently, these performance indices should be considered only as a guideline.